NPS-AM-12-C9P09R02-062

EXCERPT FROM THE

PROCEEDINGS

OF THE

NINTH ANNUAL ACQUISITION RESEARCH SYMPOSIUM WEDNESDAY SESSIONS VOLUME I

Business Models for Cost Sharing and Capability Sustainment

Michael Pryce
Manchester Business School

Published April 30, 2012

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 APR 2012		**00-00-2012 to 00-00-2012**

4. TITLE AND SUBTITLE	
Business Models for Cost Sharing and Capability Sustainment	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Manchester Business School,The University of Manchester,Booth Street West,Manchester, M15 6PB, UK,**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S)
	11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
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15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**31**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

The research presented at the symposium was supported by the acquisition chair of the Graduate School of Business & Public Policy at the Naval Postgraduate School.

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Acquisition Chair
Graduate School of Business and Public Policy
Naval Postgraduate School
Monterey, CA 93943-5103
Tel: (831) 656-2092
Fax: (831) 656-2253
E-mail: jbgreene@nps.edu

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Preface & Acknowledgements

Welcome to our Ninth Annual Acquisition Research Symposium! This event is the highlight of the year for the Acquisition Research Program (ARP) here at the Naval Postgraduate School (NPS) because it showcases the findings of recently completed research projects—and that research activity has been prolific! Since the ARP's founding in 2003, over 800 original research reports have been added to the acquisition body of knowledge. We continue to add to that library, located online at www.acquisitionresearch.net, at a rate of roughly 140 reports per year. This activity has engaged researchers at over 60 universities and other institutions, greatly enhancing the diversity of thought brought to bear on the business activities of the DoD.

We generate this level of activity in three ways. First, we solicit research topics from academia and other institutions through an annual Broad Agency Announcement, sponsored by the USD(AT&L). Second, we issue an annual internal call for proposals to seek NPS faculty research supporting the interests of our program sponsors. Finally, we serve as a "broker" to market specific research topics identified by our sponsors to NPS graduate students. This three-pronged approach provides for a rich and broad diversity of scholarly rigor mixed with a good blend of practitioner experience in the field of acquisition. We are grateful to those of you who have contributed to our research program in the past and hope this symposium will spark even more participation.

We encourage you to be active participants at the symposium. Indeed, active participation has been the hallmark of previous symposia. We purposely limit attendance to 350 people to encourage just that. In addition, this forum is unique in its effort to bring scholars and practitioners together around acquisition research that is both relevant in application and rigorous in method. Seldom will you get the opportunity to interact with so many top DoD acquisition officials and acquisition researchers. We encourage dialogue both in the formal panel sessions and in the many opportunities we make available at meals, breaks, and the day-ending socials. Many of our researchers use these occasions to establish new teaming arrangements for future research work. In the words of one senior government official, "I would not miss this symposium for the world as it is the best forum I've found for catching up on acquisition issues and learning from the great presenters."

We expect affordability to be a major focus at this year's event. It is a central tenet of the DoD's Better Buying Power initiatives, and budget projections indicate it will continue to be important as the nation works its way out of the recession. This suggests that research with a focus on affordability will be of great interest to the DoD leadership in the year to come. Whether you're a practitioner or scholar, we invite you to participate in that research.

We gratefully acknowledge the ongoing support and leadership of our sponsors, whose foresight and vision have assured the continuing success of the ARP:

- Office of the Under Secretary of Defense (Acquisition, Technology, & Logistics)
- Director, Acquisition Career Management, ASN (RD&A)
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- Program Executive Officer, Littoral Combat Ships

We also thank the Naval Postgraduate School Foundation and acknowledge its generous contributions in support of this symposium.

James B. Greene Jr.
Rear Admiral, U.S. Navy (Ret.)

Keith F. Snider, PhD
Associate Professor

Panel 9. Opportunism in Defense Contracting

Wednesday, May 16, 2012	
1:45 p.m. – 3:15 p.m.	**Chair: Dr. Fred Thompson,** Professor, Atkinson Graduate School of Management, Willamette University ***Third-Party Opportunism and the (In)Efficiency of Public Contracts*** Marian Moszoro, *IESE Business School, Barcelona* Pablo T. Spiller, *University of California, Berkeley* ***Business Models for Cost Sharing and Capability Sustainment*** Michael Pryce, *Manchester Business School* ***Endogenous Split Awards for Protest Management*** Peter Coughlan, *Naval Postgraduate School*

Fred Thompson—Dr. Thompson is the Grace and Elmer Goudy Professor of Public Management and Policy Analysis at the Atkinson Graduate School of Management, Willamette University. Dr. Thompson is a specialist in the field of tax policy and regulation.

Dr. Thompson is co-editor of the Handbook of Public Finance. He was the founding editor of the International Public Management Journal and is currently associate editor of the Journal of Comparative Policy Analysis. He has been published in numerous scholarly journals, including the American Political Science Review, Public Administration Review, Public Choice, and Journal of Economic Behavior and Organization.

In 2000 Dr. Thompson received the Distinguished Research Award of the National Association of Schools of Public Affairs and Administration and the American Society for Public Administration. In 2005 he received the Aaron B. Wildavsky Award for Outstanding Lifetime Scholarly Achievement in the field of public budgeting and financial management of the Association for Budgeting and Financial Management. In 2006 he served on the United Nations Development Program's Blue Ribbon Commission on Macedonia.

Dr. Thompson earned his Bachelor of Arts in economics and history from Pomona College and his PhD from the Center for Politics and Economics, Claremont Graduate University.

Business Models for Cost Sharing and Capability Sustainment

Michael Pryce—Pryce is a research fellow at Manchester Business School in the UK. His current project, presented in this paper, follows on from his prior work for the Acquisition Research Program, *Costing Complex Products, Operations and Support* (MBS-CE-11-196), which looked at innovative methods of costing future defense equipment. He was previously part of the 10-university NECTISE (Network Enabled Capability Through Innovative Systems Engineering) research team, exploring organizational aspects of Through Life Systems Management. [Michael.Pryce@mbs.ac.uk]

Abstract

Cost sharing in defense acquisition, with contractors sharing part of the burden of research, development, test, and evaluation (RDT&E) costs, has been suggested as a way of reducing the liability of governments to program cost overruns. While capping the costs of RDT&E and production is an excellent objective, incentivizing contractors may benefit from business models that span the entire lifecycle of a program. The potential to share the risk of cost overruns outside of RDT&E and production, and into the operations and support (O&S) area, provides a powerful incentive to get contractors to "buy in" to cost sharing, and to control total program lifecycle costs.

The research presented in this paper aims to develop new business models that allow contractors to benefit from cost sharing across all stages of program lifecycles, with a view to limiting costs during RDT&E, production, and O&S. Experience from the United Kingdom on availability contracting shows possible business models that could form the basis of an approach to cost sharing in O&S, as well as the weaknesses of some approaches tried.

A set of case studies form the basis for the findings of the research. These use the concept of complexity and interactions as outlined in prior research (Pryce, 2011), and relate this complexity to the way that current business models and contracts for development, production, and support have been structured. It also looks at how the business models and contracts might have been written if a long-term approach, across the lifecycle, had been taken into account.

The results of the case studies will provide a matrix of findings for the research, from which a set of ideal business models will be derived. These ideal business models will then be reviewed in light of the experiences of commercial organizations engaged in similar programs. In this paper initial, empirical business models are described as a basis for discussion, ahead of the final report of the research.

Introduction

The objective of the research that this paper stems from is to develop new business models that allow contractors to benefit from cost sharing across all stages of program lifecycles, with a view to limiting costs during research, development, test and evaluation (RDT&E), production, and operations and support (O&S). The sums involved can be very substantial—for example, in the latest estimates for the Joint Strike Fighter around 40% of the program costs (c. $1–$1.45 trillion) are accounted for by RDT&E and production, with the remaining 60% are accounted for by O&S.

However, the opportunities for controlling costs may vary between the stages of a program. Prior research (Pryce, 2011) indicates that RDT&E and production costs may be largely "locked in" once the degree of technical complexity of a program is decided upon. This usually occurs at a very early conceptual design stage in the program. However, the same research has illustrated that there appears to be much greater cost variance, and, therefore, active cost control, in the O&S phase.

By seeking business models that tie together all stages of program lifecycles, it is the objective of the research to enable true cost sharing to occur in defense acquisition, lowering the liability of governments to cost overruns, while ensuring contractors are incentivized and enabled to participate in cost sharing. They would then be able to spread their own risks over a full program lifecycle, in a way common to many commercial organizations engaged in the production and support of complex systems (Davies & Hobday, 2005).

Background

The complex technical and commercial risks involved in the development of new combat capabilities have been a recurring source of cost overruns in programs, stretching back many decades. While progress has been made in understanding the root causes of some historical failures and successes in a number of programs, the continued evolution of new technologies, the increasing lifespan of defense capabilities, and the ever-widening gap between new generations of capabilities have made it difficult to apply many of these lessons as widely as would be liked.

Many lessons have been learned and applied to government acquisition processes (Edison & Murphy, 2011; Nowicki, Ramirez-Marquez, Randall, & Murynets, 2011; Wang & San Miguel, 2011). However, these can only have limited benefits without concomitant changes in contractor actions and behaviors in order to ensure overall program outcomes are those desired. This involves, on the one hand, more realistic cost estimating at the outset of programs, based on realistic estimates of the nature of the technical risk being undertaken in a program. However, estimates are not a method of controlling unexpected increases in risk and cost, only of reducing the extent of the variance of the possible outturn in program costs (Pryce, 2011).

In order to enable better control of cost overruns, and to limit the government’s liability for these overruns, it has recently been proposed that cost sharing in RDT&E, and possibly also production, be pursued as a possible palliative (DiMascio, 2011). Cost sharing would see the government limit its liability to program costs at a percentage less than 100%, with figures of around 25% being quoted publicly for the associated liability of contractors. In such a cost sharing scenario, contractors are theoretically incentivized to minimize cost overruns by their liability for a share of the total program costs.

While this can bring a welcome element of commercial practice to the development of new technologies, it is by no means an assured way of reducing risk. Indeed, it may simply serve to reduce the level of technical risk by reducing the advance in the level of warfighting capability being developed to one that is little more advanced than the current state of the art. In such a case, while costs may be less likely to overrun, and may be lower overall than a more advanced capability, the benefits of the lower risk solution may be sufficiently low to make it a poor choice in terms of cost/effectiveness when compared to an apparently more risky, but higher capability, system.

The judgment of program costs, risks, and capabilities is a constant challenge in all high technology areas. However, it is not just defense that suffers from these difficulties. In major civil aerospace programs, similar issues also pertain. The recent lessons of how cost overruns in RDT&E can surprise even the most careful commercial organizations are shown by the case of the Boeing 787 and Airbus A380 airliners, where unexpected technical risks caused huge cost overruns in the order of billions of dollars (Norris & Wagner, 2009). However, the ability of commercial organizations to spread the impact of these risks over a full production, operations and support cycle, as well as utilizing financing mechanisms in the commercial market, means that they are able to absorb such risks, and attendant cost overruns, in the development stages.

It is the purpose of the research that this paper partly reports to outline how defense acquisition could use cost sharing across the lifecycle to enable capability sustainment in a way that benefits the government and contractors, using commercial practices and experience, while allowing technical advances to be made that warrant the costs incurred. In this paper, these aspects are illustrated by reporting on two of the case studies in the research in detail, the Harrier and Typhoon combat aircraft from the UK.

Research Approach

In order to allow cost sharing benefits to work for both the government and contractors, it is essential that the business models used for each program be tailored to meet the needs of both parties. In the UK the Ministry of Defence and several major contractors (such as BAE Systems and Rolls Royce) have spent many years moving towards the contractor provision of support for availability (Booth, 2011). This has been a difficult process, and one of the many lessons learned has been that a “one-size-fits-all” approach does not work. However, a number of successful availability support contracts have been created, and valuable experience has been gained from them.

In the UK, the Harrier and Typhoon programs have been the source of business model innovation, as well as indicating some of their limits. In particular, it has been found that within each program a process of constant evolution is required, as new operational practices, technological advances, industrial re-organizations, and government policies have had a significant impact on the capability support enterprise. A number of other significant issues have been found to recur in the UK, and, over time, it has been seen that the business models need to be built to accommodate them.

Most notable of these issues is the ability of the customer to terminate the use of a major system, or the development of a program, that can lead to the loss of most of the projected O&S revenue for the contractor over many decades. The most extreme examples of this have been shown in the recent (October 2010) Strategic Security and Defence Review (HMSO, 2010). This saw a radical reduction in the size and scope of the UK’s armed forces, and the cancelation of a number of programs.

This included the removal of the UK’s Harrier STOVL aircraft fleet from Royal Air Force/Royal Navy service, and the downsizing of the RAF’s Tornado strike aircraft fleet, as well as changes to the planned UK acquisition of the STOVL F-35B aircraft in favor of the F-35C carrier variant. Both Harrier and Tornado programs had been subject to contractor-led support contracts that had led to significant savings in O&S costs. However, the contracts had been let in such a way as to allow for modifications, cancelations, and reductions to the fleets, allowing procurement flexibility.

In contrast, the UK decided to retain its commitment to Typhoon combat aircraft and the new CVF aircraft carriers. In both cases, these were still in the development and production phases, and the contracts for these phases were such that penalty charges for cancelation would have been more expensive than continuing with the programs.

This meant that the desire to retain the development and production of these programs shaped UK defense policy, even though the government is on record as not actually wanting the new aircraft carriers, and of getting rid of the Harrier fleet with regret (HMSO, 2010). In order to save money in the short term, to meet financial limits imposed by the state of the national economy, long-term support contracts have had to be canceled to produce savings, while the shorter term development and production contracts have been retained.

This was brought about by the “traditional” approach to development and production contracts in the UK, with these being subject to tough negotiation, and then “set in stone,” in order to keep the contractor bound to meeting their strict terms. In contrast, as mentioned above, support contracts have been written in “softer” terms, to account for the changes that happen over time in O&S. On the Typhoon program, the desire to limit lifecycle costs has led to negotiation, with BAE Systems and the other European builders of the aircraft (EADS-Cassidian and Alenia) for a 30% reduction in O&S costs, with a contract signed at the end of March 2012.

However, this approach is less than ideal. In order for the government to meet short-term savings, it finds itself committed to the annually more expensive, rigidly contracted, development and production of systems it does not want, while contractors may lose the larger total value of long-term support contracts in order to retain the short-term, and more risky, development and production contracts.

In order to try to evolve a more sensible approach, where decisions can be made on a lifecycle basis, this paper aims to illustrate the issues that may inform the development of business models where risks and rewards can be spread over entire lifecycles, allowing decisions on programs to be made on the basis of their overall, long-term benefits and costs.

The overarching research issue that lies behind this paper is this: What are the best business models for government and industry to benefit from cost sharing across program lifecycles? This is then intended to lead to a research result of identifying business models that can address this issue, depending on the type of program, timescales, and other factors.

The research will answer these questions by looking at a number of case studies, from the perspective of programs, technologies and operational approaches, and by considering how UK experiences can be transitioned to the U.S. defense acquisition environment.

The approach taken by the case studies for the research (Yin, 1994) is to look at each, using the concept of complexity and interactions as outlined in prior research (Pryce, 2011), and to relate this complexity to the way that the business models and contracts for development, production, and support have been structured. It will also look at how they might have been written if a long-term approach, across the lifecycle, had been taken into account and if the complexity of this approach had been properly understood.

The full set of case studies in the research include the following:

- Programs
    - F-35 Lightning II (U.S./UK)
    - AV-8B/Harrier (U.S./UK)
    - Super Hornet (U.S.)
    - Typhoon (UK)
- Technologies
    - Carbon fiber
    - Computing
- Operational aspects

- Land-based combat aircraft
- Sea-based combat aircraft

In this paper, results for Harrier and Typhoon Programs are presented. The full report, due in June 2012, will provide findings for all cases and a full analysis and recommendations.

The technologies cases explore how business models and contracts may have to change in light of possible changes in materials and computing technologies over time (the implications of such changes are indicated by Hullander and Walling, 2008, and Pryce, 2011). The operational aspects cases, notably the impact of sea-based versus land-based operations of combat aircraft on the distribution of lifecycle costs, follows on from research comparing UK and U.S. carrier aviation using the UK “Lines of Development” approach (Pryce, 2009).

As an initial step of the research, the literature on commercial business models was reviewed in order to identify issues that may be either common to, or different from, defense experiences, needs, and practices.

Literature Review

The need to sustain, extend, and modify defense equipment and organizational capabilities over a period of decades means that defense acquisition faces challenges that feature little in the existing academic literature on business models. There have been a number of definitions given for what a business model is, but in this paper the definition of Casadesus-Masanell and Ricart (2010) is accepted, namely that a business model is “is a reflection of the firm’s realized strategy” (p. 195). This is important, as it notes the difference between a business model and a strategy, and the importance of understanding the contingent nature of business models.

Such contingencies derive from the circumstances within which the enterprise finds itself operating. The complex, long-term nature of defense equipment acquisition and use, as well as the need to constantly update technologies and skills in the light of emergent threats, lead to a situation where understanding the need and ability of organizations to respond to multiple, changing interactions (Pryce, 2011) is essential to creating a successful business model.

Even the insertion of relatively simple technologies into existing systems can have profound implications for firms in the civil sector. Bjorkdahl (2009) notes that integrating new digital technology into existing mechanical products and their supporting processes can only work correctly if the firm carrying out the integration changes its entire business model. Changing the business model, for example by moving to licensing rather than selling of technology, rather than the overall strategy (e.g., to dominate a sector), is key to maximizing value for the user as well as the producer. This aspect of user-focused value enhancement also forms part of the understanding of what a business model is that underpins this paper.

From these two works, we can arrive at the working definition of a business model used in this paper; namely, a business model is a way of jointly realizing value for producers and users in an interactive way that goes beyond a strategy and evolves, often rapidly, over time.

This change over time in a commercial field may be a response to external economic and market events upsetting an equilibrium, driving business model innovation in order to lead to a period of growth (Sosna, Trevinyo-Rodriguez, & Velamuri, 2010). This growth is based on a new equilibrium established by the new business model, which, in effect, becomes a transition phase between strategies. This differs from the defense realm, where change is constant and any equilibrium is short lived, especially in relation to the multi-decades-long lifecycles of much defense equipment.

Rather, in order to engage with defense issues, business models need to adapt in a continuous process in most cases, notably the major platforms and technologies featured in this research. Demil and Lecocq (2010) have identified the need for core parts of the evolving business model to enable a process of "dynamic consistency" in order to ensure that the competitive advantage of the firm still benefits from the process of evolution, as well as the needs of the user. This dynamic consistency is not in the form of a rigid set of relationships between the organizations, resources, or products that the business model is concerned with, but is seen, instead, in a consistent set of outputs. While for a firm this output is profitability, for the defense community it could be, for example, capability or availability. The business model, as seen by Demil and Lecocq (2010), delivers dynamic consistency by ensuring that profitability and capability evolve in mutually beneficial ways, while being less concerned with fixing a particular set of relationships to accomplish this outcome.

The idea of a business model being concerned with mutual and diverse benefits to users and producers, as well as being subject to constant change over time, is one that sits well with the concept of interactions as being the key lens through which to view the costing of complex products, such as defense equipment (Pryce, 2011). While costing O&S is a difficult proposition, the concept of interactions offers a way of doing this that should also enable the development of business models that recognize the constant state of change brought about by such interactions. It should also illustrate their implications for the cost of O&S, as well as identifying areas of possible mutual benefit (e.g., where capability can be enhanced at little cost in comparison to other possible options).

The following case studies identify approaches by UK industry and the UK armed forces that have already moved in this direction.

Case Study 1: Harrier

During the period 2005–2010, the UK's Joint Force Harrier fleet of STOVL combat aircraft was updated both as part of a planned enhancement of capabilities and in response to their deployment in Afghanistan. There, a number of new needs were identified and the critical importance of a rapid response by industry was realised. Central to the technical solutions put forward by BAE Systems and their partner companies were a number of new capabilities of an advanced nature, implemented using simple tools (Lucas, 2008). This developed into a process known as Rapid Technology Insertion (RTI), which was implemented through the use of a team that was focussed around developing and implementing RTI.

Central to this development was an approach on the part of industry that managed risk through the anticipation of user needs and partnering with the user to develop and deploy them. This was carried out within a dynamic contracting environment that saw increasing amounts of maintenance carried out by industry, both in support of RTI and for more routine work.

The RTI process enabled Joint Force Harrier to exploit technologies as they become available and was an important feature in meeting the demands of the front-line squadrons where flexibility, responsiveness, timeliness, and military effectiveness were vital.

Harrier RTI Business Model

In order to meet the emergent needs from Afghanistan, the ongoing updates of the Harrier and additional needs from changes in UK Ministry of Defence (MoD) policy, BAE

System's Harrier work was part of a network of stakeholders who formed partnering arrangements to carry out the Harrier upgrades. The RTI activities involved the coordination of all the other parties in the process of identifying requirements and solutions, gaining contracts, and implementing the solution. An important role in the RTI process was to ensure that the requirements that emerged from the Operational Evaluation Unit (OEU) were endorsed by the RTI team before being passed over to the MoD for approval. It had been seen that unendorsed requirements passed directly to the MoD had been the cause of problems in the past. For example, they led to a narrow Urgent Operational Requirement (UOR) being issued, where the RTI team may have been aware of additional issues around the identified requirement, and its potential solutions, that the OEU's perspective did not allow it to see.

This was seen as a vital part of the RTI team's business model, anticipating customers' future needs beyond their stated ones and, therefore, ensuring future business opportunities, as well as speeding up future upgrades as they emerged from customer experiences. This was enabled by customer representatives working as part of the RTI team and being willing to communicate up the customer hierarchy via the RTI team. This was greatly facilitated by key RTI team leaders being ex-Service personnel with direct knowledge and experience of front-line operations and of working on an OEU.

The overall structure of the Harrier RTI business model is shown in Figure 1.

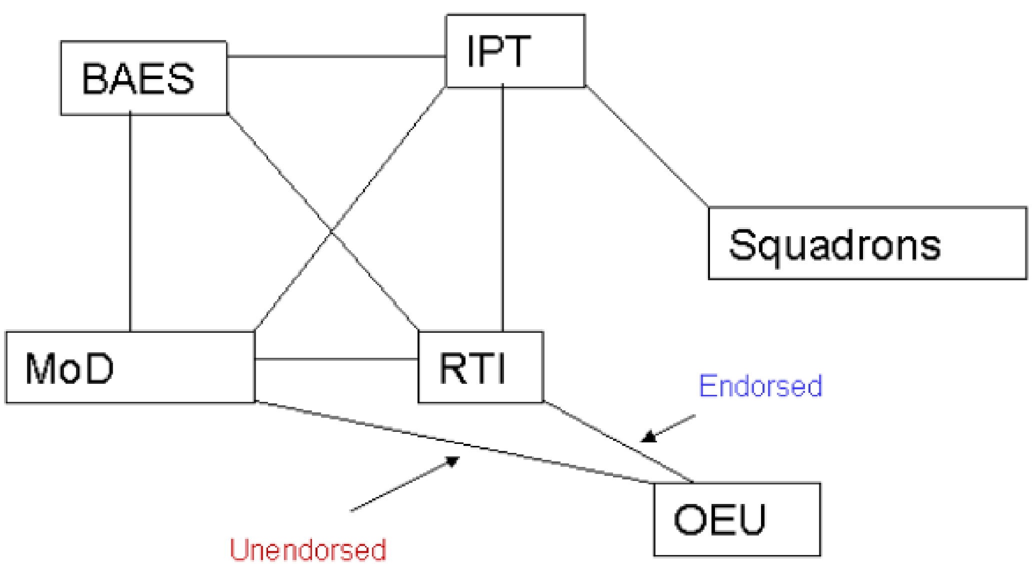

Figure 1. Harrier/RTI Business Model

Note. BAES—BAE System, MoD—UK Ministry of Defence, IPT—Integrated Project Team, RTI—Rapid Technology Insertion Team, OEU—Operational Evaluation Unit

Partnering and Private Capital

Central features of the anticipatory nature of the Harrier RTI team's work was the use of partnering and private capital to both speed up the overall process of technology insertion and ensure that they were able to link with partner companies ahead of the issue of a specification or a contract from the MoD customer.

An example of this is the integration of the Lockheed Martin Sniper targeting pod (referred to as the Advanced Targeting Pod [ATP]). From September 2006–April 2007, the RTI program was funded by BAE Systems, with a contract from MoD only following in May 2007. This required BAE Systems and MoD to partner closely with Lockheed Martin, who they were competing with in other programs, with the level of trust essential to enable this to happen. The ability to focus the business model around the RTI team, rather than at the level of BAE Systems, enabled this flexibility. The overall ATP program of events is shown in Figure 2.

ADVANCED TARGETING POD - TIMELINE		
2006	First contact with Lockheed Martin	15th September
	Initial Industry Rapid Technology Insertion Meeting	28th September
	Industry funded Aircraft / Pod integration, development and testing	October-November
	First Sniper capability demonstration flight	1st December
	DPA Pod competition	December-January
2007	Sniper selected, Industry resumes integration, development and certification activities	8th February
	Initial OEC Advice Issued for Operational Evaluation (OpEval)	16th March
	Start flight testing of improved software	21st March
	41(R)Sqn OpEval	Mid March – Mid April
	BAE SYSTEMS UOR contract award	11th April
	Integration and certification activities complete and squadron training starts	18th May
	GR9/9A Release To Service	25th May
	GR7A Integration and testing	18th May – 3rd August
	GR7A Release To Service	29th August

Figure 2. Advanced Targeting Pod/RTI Timeline

Note. The source for this figure is BAE Systems Rapid Engineering: Harrier UOR Experiences, an internal company document.

BAE Systems' private venture capital was also used to further develop the ATP solution and to give interim clearance advice to enable the OEU, 41(R) Squadron to conduct operational evaluation trials in fewer than four weeks from receipt of a Request for Quotation.

Implications of the Business Model

While the Harrier aircraft has many platform-specific issues, such as a relatively low level of systems integration and related cross-systems dependencies (in comparison to Typhoon, for example), which allowed quick development and implementation of new capabilities, this does not mean that the lessons from Harrier could not be applied more widely. In particular, the partnering approach allowed for by the use of the RTI model appears to be one that could be adopted widely. Even within BAE Systems, this was seen as being of great value and efforts were made to learn internally how the Typhoon aircraft could benefit from an RTI approach.

Externally, the use of a small group, such as the RTI team, that is focused on anticipating customer needs, intimately involved in the development and implementation of requirements, and able to use their own funds to develop work in advance of contract issue, would seem to be of great value in defense acquisition and the sustainment of capabilities over a long time frame.

In order to identify the key factors in the Harrier RTI success, a SWOT analysis was carried out. The results are shown in Table 1.

Table 1. SWOT Analysis of Harrier

Strengths Small team UK/BAE controlled RTI	**Weaknesses** Small program—little political support BAE see "Harrier way" as cheap, so profits low
Opportunities JSF delay Combat use CVF integration trials	**Threats** Strategic decision to cancel Harrier MoD lose tacit understanding of Harrier IPT methods

Strengths

- Small team. The relatively small team on Harrier (c.600 BAES staff at all locations and in all disciplines), due in part to the fact that it was no longer in production, meant that decisions could be made quickly. All key senior personnel had desks located on one floor of a single building, with decisions able to be "walked around" quickly.
- UK/BAE controlled. Unlike a number of other projects, Harrier was effectively a UK-only program. This made decision-making easier, as it did not require the agreement of partners in other countries.
- RTI. This is a major factor in the success of the Harrier team and is the basis of their successful business model.

Weaknesses

- Small program—little political support. The fact that Harrier was a relatively small program meant that it was not the main "political" priority for anyone in industry or government. There was a constant need to prove the utility and effectiveness of the program, whereas on other programs (e.g., Typhoon) there was senior managerial and government support. In addition, as the Harrier was not in production, many fewer jobs depended on it.
- BAE's strategic management saw the "Harrier way" as quick and cheap, so lacking in a steady, high-volume cash flow. This lack of "political" support was mirrored in the lower scale of turnover and overall profits (but not profit rate) that Harrier delivered to BAE Systems, which meant that it was not seen as a "core" program for many managers in the company.

Opportunities

- JSF delay. The intended successor to the Harrier, the F-35B Lightning II Joint Strike Fighter (JSF), is currently due to enter service at the end of the current decade. Even if it is procured by the UK as planned, the program is still at an early stage of flight testing and manufacturing, and it was thought that the RTI process would need to address these possible delays (before the Harrier's UK cancellation in late 2010).
- Combat use. The experience of Harrier in Afghanistan meant that the squadrons, maintenance organization, and industry had extensive current experience of working closely together to meet customer needs.
- CVF integration trials. The intended replacement aircraft carriers for the Royal Navy, known as CVF, require integration with the aircraft intended to operate from them. The RTI team considered it possible to undertake trials of some

common equipment between Harrier and JSF in order to "de-risk" the latter, notably the Advanced Targeting Pod, which is a pod-mounted version of the internal targeting equipment to be fitted to JSF.

Threats

- Strategic decision to cancel Harrier. The UK's decision to cancel Harrier was realized in late 2010, but had been anticipated as possible by the RTI team, who shaped their activities to reduce its likelihood, although to no avail. However, the Harrier team, much diminished, still supports the international Harrier fleet and the sale of UK Harriers to the U.S.
- MoD loses its tacit understanding of Harrier IPT methods. The success of Harrier with its customer was the result of working closely with MoD, who enabled the work to happen in the way it did and supported it in large measure. But as the Harrier RTI team was central to this, their loss may mean the loss of customer knowledge of the business model and how to make it succeed.

In order to see if the lessons of the Harrier RTI business model are applicable, work was carried out with contacts in BAE Systems working on Typhoon. The results are reported briefly in Case Study 2.

Case Study 2: Eurofighter Typhoon

The Eurofighter Typhoon combat aircraft program is a large-scale development, production, and support program for the UK MoD and BAE Systems. Features that differentiate it from the Harrier include the following:

- A high level of systems integration and related cross-systems dependencies,
- A four-nation international development and production partnership, and
- Limited service use and operational experience in limited roles.

In comparison to the relatively agile nature of Harrier RTI activities outlined above, Typhoon can seem rather less agile. For example, in interviews with Typhoon engineering personnel in BAE Systems, it was stated that a targeting pod integration similar to the Harrier's ATP took seven years on Typhoon, as opposed to the timetable of less than one year for Harrier, as shown in Figure 2.

These factors and characteristics mean that a Typhoon business model for sustainment may require different approaches from those of Harrier. However, the framework in which they can take place, namely a partnered support and update infrastructure, was in place on Typhoon in its early deployment, namely the very closely partnered "Case White," which was Typhoon's introduction to service.

Case White was intended to support Typhoon's move to its initial UK operational base at RAF Coningsby in July 2005 after a period of "working up" at BAE Systems' Warton facility. It was intended to deliver the ability to deploy Typhoon overseas and on NATO commitments and, therefore, bridged the initial period in service with the UK Royal Air Force (RAF).

BAE Systems was contracted for 1,300 flight hours from Warton, the training of 16 pilots from the Operational Evaluation Unit and Operational Conversion Unit, and the further training of nearly 200 RAF engineering personnel. By operating initially from a BAE Systems facility, and by partnering with the MoD not just in training engineering personnel but also in provisioning of sustainment activities at RAF Coningsby, BAE Systems hoped to both ease Typhoon into service and to leverage the corporate engineering knowledge gained during development of Typhoon into the sustainment of the aircraft in service.

Case White itself is considered to have been successful. However, the “handover” of Typhoon to the RAF was not as smooth as would be hoped. In part this was due to the Case White engineering and management team at BAE Systems moving to support the purchase of Typhoons by Saudi Arabia. With the full introduction of Typhoon to RAF service, there was a subsequent reduction in partnering activities, although the RAF is still aiming to use BAE Systems as part of the overall sustainment activities. Recent contracts, such as the award of the £450 million Typhoon Availability Service (TAS) contract in March 2009 and the signing of a four-nation support agreement in March 2012, appear to be moving back towards a situation like that in Case White. Notably, the further integration of new capabilities in Typhoon is part of the new support contract and reduces support costs, which mirrors the purpose, if not the structures, of the Harrier RTI business model.

The key differences between the Typhoon and Harrier experiences are shown in the SWOT analysis summary in Table 2.

Table 2. SWOT Analysis of Typhoon

Strengths Large program High turnover/long timescale	**Weaknesses** Large team Four nations—slow Complex systems
Opportunities JSF delay New weapons/roles	**Threats** JSF capabilities Limited combat use

Table 2 shows that Typhoon is in many ways the inverse of Harrier in terms of strengths and weaknesses. This could imply that a very different business model is required. In the final section, this issue will be discussed to illustrate how such apparent differences can mask potential synergies that can be harnessed in business models.

Summary and Discussion

The purpose of the research that this paper partly describes is to see if robust business models can be developed that improve the sustainment costs of defense programs, both for contractors and service users.

In order to do this, it appears that a sustainable way of engaging contractors in O&S activities can offer a way to offset the expense of early development and may, in time, produce ways of shifting the burden of cost sharing away from development and production, instead focusing it across the lifecycle.

The concept of the business model has been described as being focused on change and outcomes for both users and producers, rather than as a company adopting a strategy that it then implements in a linear fashion. A good business model is does not define the means, whether organizational structure, resources, or products, but, instead, enables the desired ends of sustainment activities for both contractors and government users. The fact that these ends are different for the two sides, and can change over time, is the area where a good business model reveals itself through its ability to deal with emergent needs and contingent circumstances in an agile manner.

In the case studies it can be seen that the Harrier RTI exercise appears to have passed muster as a good business model, because it addressed the needs of the user community for new capabilities, developed and deployed rapidly, and allowed the company to profit from these. In large part this success was due to the Harrier RTI team's ability to anticipate future user needs, rather than just responding to them in piecemeal fashion.

The Typhoon case by comparison shows that although the Case White exercise was successful, it was not sustained beyond its initial, narrow objectives. Additional sustainment partnering activities have had to start afresh, with a loss of the knowledge previously gained and through contracts with different partners.

While these differences can be ascribed to the more complex technical nature of the aircraft, or the four-nation consortium that developed it, the fact that the business model of Case White could not overcome these limitations shows that it was not sufficiently robust for through life sustainment activities, although it functioned in its narrow remit for a period of time.

It, therefore, seems that business model analysis should focus on systems that show the necessary robustness to deal with the changes inherent in the defense environment, with its myriad technical, organizational, and operational interactions. How this is done will be fully covered for all the case studies to be looked at in the research for the final report, due in June 2012.

This report will evaluate not only what can be learned from analyzing business models for the sustainment of platforms at different phases of their lifecycle, but also how innovative and disruptive technologies can be incorporated into robust business models, such as the use of EPIC (Electric Potential Integrated Circuit) sensors for the support of carbon fiber and stealth materials, and at the translation of business models between nations.

References

Bjorkdahl, J. (2009). Technology cross-fertilization and the business model: The case of integrating ICTs in mechanical engineering products. *Research Policy, 38*, 1468–1477.

Booth, D. (2011, April 12). *Developing a risk strategy for CLS contracts*. Paper presented at the Society for Cost Analysis and Forecasting Workshop on Estimating the cost of Operating and Support in a Changing Commercial World, Bristol.

Casadesus-Masanell, R., & Ricart, J. E. (2010). From strategy to business models and onto tactics. *Long Range Planning, 43*, 195–215.

Davies, A., & Hobday, M. (Eds.). (2005). *The business of projects*. Cambridge, UK: Cambridge University Press.

Demil, B., & Lecocq, X. (2010). Business model evolution: In search of dynamic consistency. *Long Range Planning, 43*, 227–246.

DiMascio, J. (2011, June 10). Panetta hints at contractor cost sharing. *Aviation Week and Space Technology*.

Edison, T., & Murphy, A. (2011, May). Performance-based life cycle product support: A new look at enablers and barriers. In *Proceedings of the 8th Annual Acquisition Research Symposium*. Monterey, CA: Naval Postgraduate School.

Hullander, T., & Walling, D. (2008, December). *Tailoring an ASIP for the USMC Harrier II Aircraft* (NAVAIR Public Release, SPR08-1107.257). PMA-257. Paper presented at the 2008 USAF Aircraft Structural Integrity Conference.

Lucas, J. (2008). Safety case experiences from Harrier. In *Improvements in System Safety 2008* (pp. 77–91). Springer.

Norris, G., & Wagner, M. (2009). *Boeing 787 Dreamliner*. Minneapolis, MN.

Nowicki, D., Ramirez-Marquez, J., Randall, W., & Murynets, I. (2011, May). Optimal cost avoidance investment and pricing strategies for performance-based post-production service contracts. In *Proceedings of the Eighth Annual Acquisition Research Symposium*. Monterey, CA: Naval Postgraduate School.

Pryce, M. (2009, May). Acquisition of capabilities through systems-of-systems: Case studies and lessons from naval aviation. In *Proceedings of the Sixth Annual Acquisition Research Symposium: Defense acquisition in transition* (Vol. 1). Monterey, CA: Naval Postgraduate School.

Pryce, M. (2011). *Costing complex products, operations & support* (MBS-CE-11-196). Monterey, CA.

Sosna, M., Trevinyo-Rodriguez, R. N., & Velamuri, S. R. (2010). Business model innovation through trial-and-error learning: The Naturhouse case. *Long Range Planning, 43*, 383–407.

Wang, C., & San Miguel, J. (2011, May). Unintended consequences of advocating use of fixed-price contracts in defense acquisition practice. In *Proceedings of the Eighth Annual Acquisition Research Symposium*. Monterey, CA: Naval Postgraduate School.

Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.). London.

Acknowledgments

The author would like to thank the staff at BAE Systems who read draft material that features in this paper, several anonymous interviewees within the company, and colleagues at Manchester Business School and the University of Manchester Aerospace Research Institute who have been helpful with discussions during the research.

Graham Roe, former Military Requirements Director at BAE Systems, was also supportive through discussions, and, as part of the work supporting this paper, kindly gave a useful seminar on the future of the defense aerospace business.

The material in this paper is based upon work supported by the Naval Postgraduate School Acquisition Research Program under Grant No. N00244-12-1-0012.

ACQUISITION RESEARCH PROGRAM
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY
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Manchester
Business School

MANCHESTER 1824

NAVAL POSTGRADUATE SCHOOL

Business Models for Cost Sharing & Capability Sustainment

Dr Michael Pryce,

Manchester Business School,

9th Annual Acquisition Research Symposium, Monterey

16th May 2012

This material is based upon work supported by the Naval Postgraduate School Acquisition Research Program under Grant No. N00244-12-1-0012.

Background

- Follow on NPS project
- Costing Operations & Support
- Complexity/cost variance at early stage

Research Overview

- Cost sharing in O&S
- Understand business models that work
- Characteristics of a good model
- Lessons learned & Implementation

Case studies

Programs

• F-35 Lightning II (US/UK)	• Super Hornet (US)
• AV-8B/Harrier (US/UK)	• Typhoon (UK)

Technologies

• Carbon fiber	• Computing

Operational aspects – combat aircraft

• Land based	• Sea based

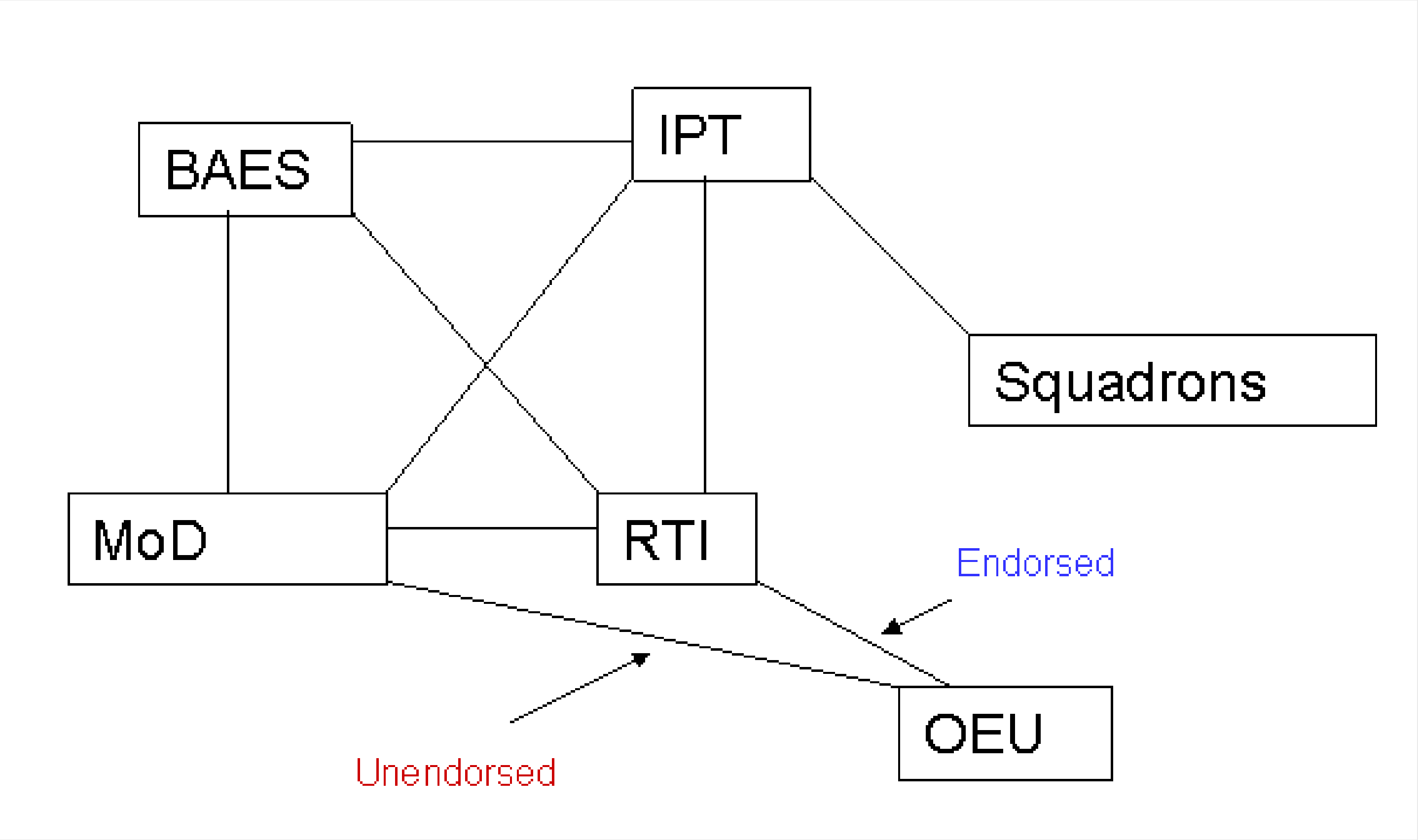
Prior findings & assumptions

- ‘Interactions’ drive costs
- Wide scope for cost variance in O&S
- Business models are not strategy
- Contingencies & change

Harrier GR.9

- Driven by RTI
- More than UoR
- Exemplary behaviors
- Team work/experience

BAE Systems Harrier Business Model



Harrier GR.9 SWOT analysis

Strengths Small team UK/BAE controlled RTI	**Weaknesses** Small programme – little political support BAE see 'Harrier way' as cheap, so profits low
Opportunities JSF delay Combat use CVF integration trials	**Threats** Strategic decision to cancel Harrier MoD lose tacit understanding

Typhoon 'Case White'

- Consortium
- EIS support
- Staff re-deployed

Typhoon 'Case White' SWOT analysis

Strengths	**Weaknesses**
Large programme High turnover/long timescale	Large Team Four nations – slow Complex systems
Opportunities	**Threats**
JSF delay New weapons/roles	JSF capabilities Limited combat use

Interim findings

- Business models deal with contingencies
- Success is in the implementation
- Constant learning
- Report June 2012

Thank You

Questions?